Chapter 10  Parabolic Flight Experiments by Students from the Asia-Pacific Region

Japan Aerospace Exploration Agency and the Japan Space Forum  
Muneo Takaoki  
The National Space Agency of Malaysia  
Mohd Helmy Hashim, Mohd Fairos Asillam  
National Science and Technology Development Agency of Thailand  
Sawat Tantiphanwadi

ABSTRACT Space agencies in the Asia-Pacific region have been supporting their students conducting parabolic flight experiments in collaboration with the Japan Aerospace Exploration Agency (JAXA). During the period 2005-2010, eight student teams from Malaysia and Thailand took this unique opportunity. What they gained through their experience was not just knowledge on sciences under microgravity but also synthetic capabilities to conduct scientific research projects. The students experienced planning, equipment design and construction, safety verification, in addition to rare in-flight operations. Cultural exchange with Japanese students was another significant benefit. It is to be hoped that the scale of this program will expand to provide future opportunities for more students in the region.

Introduction

As the only participant in the International Space Station (ISS) program in Asia, the government of Japan promotes international cooperation with countries in the region by providing them with the opportunities to use “Kibo” for experiments (1). The Japan Aerospace Exploration Agency (JAXA) has been advancing various kinds of cooperation with countries in the area through the framework of the Asia-Pacific Regional Space Agency Forum (APRSAF) as part of such promotion. A working group, then called ISS Working Group (ISS WG) and later renamed the Space Environment Utilization Working Group (SEU WG), was set up under APRSAF to explore the possibility of joint utilization in 2005 (2), and has been studying joint cooperative activity plans to be conducted on board the ISS and its Japanese Experiment Module “Kibo”. To further promote such activity, JAXA also established the “Kibo” Utilization Office for Asia (KUOA) under the Space Environment Utilization Center in its Human Space Systems and Utilization Directorate in July 2010.

At the ISS (SEU) WG of APRSAF-12 in 2005, JAXA introduced its education programs related to ISS utilization activities. The program included video communications with astronauts onboard the ISS, observations for high school students to compare protein crystal grows in space and on the ground, parabolic flight experiments for undergraduate and graduate students, video libraries, summer schools, science camps and workshops for the educational utilization of “Kibo”.

Among space related activities, the parabolic flight experiment system is truly useful and even indispensable in many ways. The condition of about 20 seconds of weightlessness produced by parabolic flight maneuvers of an aircraft is utilized for various purposes relating to the use of space environment, such as verifying the hardware function and operation procedures, crew training, preliminary observations
for space experiments, and the education of future space professionals. For these purposes, parabolic flights have been operated by Diamond Air Services, Inc. (DAS) based at Nagoya airport in Japan since 1990. To educate future space professionals, the Japan Space Forum (JSF), commissioned by JAXA, started to invite parabolic flight experiment proposals by Japanese students in 2002.

Parabolic flight experiments by students were recognized as one of the most suitable activities to precede experiments to be performed onboard the ISS, not only for students but also teachers and even young staff of the space agency who provide instructions and advice. The SEU WG of AP’RSAF planned to conduct a similar program for students in the Asia-Pacific region. A Thai student team, sponsored by the National Science and Technology Development Agency of Thailand (NSTDA), conducted the first Asian students’ parabolic experiment in 2006. The National Space Agency of Malaysia (ANGKASA) sent their first student team in 2007.

Program Management

Selection procedures

Initially, students’ proposals were collected and screened by the sponsor agency of their own country and then examined for technical feasibility and compatibility with aviation safety regulations in Japan. In 2007 and 2008, the students’ proposals from Malaysia and Thailand were examined and selected by the committee which was assembled by JAXA for selecting Japanese students’ proposals. Subsequently, at the 15th session of APRSAF held in Hanoi, Vietnam in 2008, its SEU WG recommended that the Asian students’ parabolic experiment program be conducted on a medium term basis. This was in order to secure sufficient time for students to improve their experiment plan and fabricate their equipment, which was too short on a yearly basis, as in the past. Correspondingly, a task force to support students in developing their capabilities was established by the SEU WG of APRSAF.

Each member agency of the task force invites students in its own country to submit and evaluate their proposals. The agency submits one or more proposals for equipment fabrication, travel and other student expenses to the task force, for which it will bear the cost if the proposed experiment is assigned for flight. The task force examines each proposal in terms of its relevance to gravitation, conformity with aviation safety, technical feasibility, and maturity, and advises the students as required to improve their
proposals. In some cases, students are also invited to attend task force web meetings to be advised directly by experts.

The task force nominates final candidate experiments when they meet all flight criteria. About four months before each flight, engineers from JSF and DAS visit the students’ school to hold an interface coordination meeting. Technical coordination is used to fabricate equipment operable on board the aircraft, including electrical and mechanical interfaces and ensuring conformity with safety requirements. One month before the flight, a technical confirmation meeting is held to verify the performance of the equipment and overall readiness for the flight experiment (Fig. 1).

**Operation**

Parabolic flights have been operated by Diamond Air Services, Inc. (DAS) based at the Nagoya airport in Japan since 1990. A standard 14-day experiment operation consists of 5 flight days and 8 to 14 parabolic maneuvers per day. Normally, each student team is allocated half the standard resources, one week operation with 2 flight days and half the experiment rack space (550 D × 650 W × 550 H mm) in order to accommodate their experiment. A typical timeline is shown in Fig. 2.

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**Fig. 2. Typical timeline for students’ experiments at Nagoya Airport**

Students arrive in Nagoya airport on day 1 and unpack their equipment, install it to the experiment rack and verify its functions. The preparation continues the next day, whereupon safety verifications, including for electromagnetic interference tests, are performed. The flight experiments are performed for the next two successive days.
**Track Record**

**FY 2006**

A Thai student team conducted the first experiment in this program in February, 2007.

**Theme: Study of medical drug dispersion under the microgravity environment**

**Team members (Thailand):**

Mahidol University

Apaporn Boonyarataphan

Saint John's International School

Sarunporn Boonyarataphan

**Research Advisor:** Dr. Sawat Tantiphanwadi

**Objective:** To observe the dispersion behavior of a medical drug under a microgravity environment. The result obtained can be used to determine the effectiveness of drugs in the form of a pill or tablet when taken by astronauts under microgravity or space conditions.

**Procedure:** Ten test tubes filled with degassed water were prepared for each flight which could last for ten parabolic flight cycles. On top of each of the test tubes, was a plastic syringe with an opening large enough for a pill to drop off after the syringe was pushed. A piece of aluminum foil was also used to separate the pill and water in the test tube. When pushed, the syringe puncher pushed the pill, breaking the aluminum foil and allowing the pill to drop onto the water.

**Result and conclusion:** The result of this study showed that the dispersion rate of the medical drug was quicker under microgravity than on the ground. This is because the lack of gravity meant there was no restricted area in which the medical drug could disperse, as opposed to microgravity, allowing dispersion in all directions. This was contrary to the initial prediction, namely that the dispersion rate of the medical drug would be slower under a microgravity environment.

Based on this discovery, it may be necessary for the medical drug to be modified in order to ensure its effectiveness when taken under microgravity or space conditions.

**Outcome:** The students were well received and widely recognized in Thai public life, including the press and TV.

**FY 2007**

Two seats for Asian student teams were available for the FY 2007 flight, and a Thai team and two Malaysian teams participated in the program. In Malaysia, two experiments were selected. They were “Characteristic of Superparamagnetic Iron Oxide Nanoparticles in Microgravity” and “Interfacial Phenomena in Polyester/LNR composites” from the Multimedia University (MMU) and Universiti Kebangsaan Malaysia (UKM) respectively as below.

**Theme: A Study of water flow by heating under microgravity conditions**

**Team members (Thailand):**

Mahidol University

Wanaruk Chaimayo

Tanapat Deesuwan

Chiang mai University
Pisit Kiatkittikul  
Chulalongkorn University  
Sitthipong Manotham  

Research Advisor: Assist. Prof. Dr. Narumon Emarat, Dr. Sawat Tantiphanwadi  

Objective: Its purpose was to study the pattern of the heat flow of heated water under the influence of microgravity. A novel PIV technique was used during the data analysis.

Procedure: Two water tanks filled with degassed water were set up for the experiment. Both were identical except for one with electricity input on the heater, while the other had no electricity applied to its heater for comparison purposes. Green lasers with fan pattern beams were used to observe the suspended polyamide particles in the water and a circular rod type heater was placed at the middle of the tank. Two video cameras were used to record the data on both tanks. Particle Image Velocimetry (PIV) software was used to analyze the data.

Result and conclusion:

Under a high gravity condition, with the swirl background eliminated, the first velocity field shows a flow pattern very similar to that of normal gravity. It should be noted that convection results in no flow at all in the change from high gravity to microgravity and vice versa. The above fields are obtained from the experiment in which the heater is operated only during the first high gravity state, however, similar results appear for the last two fields where the heater is also only operated during the microgravity state. This strongly indicates the lack of flow in water that was heated under microgravity.

An unexpected finding was found following review of the video footage right after flight. The liquid water was subject to counter-clockwise circulation under microgravity, although no circulation was expected. After further review, we note that the circulation was subject to clockwise motion when subject to forces exceeding one g. The direction changes were at the inflection points where the g-measurement was changed from greater than one g to less than one g or vice versa.

This is explainable. The liquid in the rectangular container has no circulation under 1-g, which is the initial condition. When the aircraft was in greater than 1-g mode, the pilot must have pulled the control stick. Under this condition the aircraft was rotated into a pitch-up configuration compared to the flight direction. The container was also in the pitch-up mode, causing the water inside to rotate counterclockwise, since the experiment was installed on the starboard side of the aircraft and the observer was in the center aisle.

During the transition from greater than 1-g to micro-g, the counterclockwise circulation slows down to a standstill at 1-g and reverse to clockwise direction at micro-g, which is what we observed in the video. It is interesting to notice that experimental fish who took the same flight swam in the same direction under microgravity.

The analysis shows that the assumption is correct. The patterns of heat convection in water differ for the ordinary and microgravity cases. Instead of floating up to the water surface and spreading out,
hotter water under microgravity is located still and symmetrically around the heater. No significant flow caused by heat is observed at all.

i. **Theme: Interfacial phenomena in Polyester/LNR composites**

**Team members (Malaysia):**

Universiti Kebangsaan Malaysia  
Mohd Fairuz Mat Isa  
Tong Mei Mei  
Rosniza Mohd Razali

Research Advisor / Dr. Ishak Ahmad

**Objective:** To identify the detailed crack initiation and growth behavior and develop a quantitative failure criterion.

**Procedure:**

*Materials and Sample Preparation:*

The rubber used was natural rubber (SMR L) purchased from Felda Rubber. Liquid Natural Rubber (LNR) will be prepared using the SMR L via a photochemical oxidation process.
The matrix materials are commercial unsaturated polyester resin (UPR), purchased from Revertex (M) Sdn Bhd with MEKP and cobalt octanoate as initiator and accelerator respectively.

The LNR were prepared using a photochemical oxidation process (Ibrahim & Zuriati, 1989). The composite was prepared by mixing the LNR and UPR using a mechanical stirrer for 3 hours at room temperature before carefully mixing with the initiator (MEKPO) and accelerator and casting into a stainless steel mold (Fig. 5). The materials were then treated at atmospheric pressure for 24 hours at room temperature followed by post treatment for 3 hours at 60 and 120°C. The samples were cut as in Fig.6.

Experiment Method:
A fracture study was characterized at normal and microgravity using a compact-tension specimen containing a mid-plane crack 25 mm long as detailed in Fig. 7. A milled central groove was also present to conserve dimensional similarity with the fatigue work details later, which also ensured a planar crack growth front. A cutter was used to propagate the crack, which ensured that crack growth would originate from a sharp crack tip and samples were tested using a straining rig and micrometer. The micrometer was twisted to apply load for the deboning process. All the data were collected during the experiment. A fracture mechanism was observed after the test. A 90/10% sample of UPR/LNR composition was used in this microgravity experiment.

![Graph showing fracture study results](image)

**Table 1:** Results of fracture study

<table>
<thead>
<tr>
<th>MICROMETER VALUE (mm)</th>
<th>NORMAL GRAVITY (mm)</th>
<th>MICROGRAVITY (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>0.3</td>
<td>7.2</td>
</tr>
<tr>
<td>11</td>
<td>11.1</td>
<td>25.7</td>
</tr>
</tbody>
</table>

Fig. 7. Results of fracture study
A tendency for a matrix crack to form along the matrix/matrix interface was observed. The effect of microgravity on the interfacial adhesion was understood by performing the test in a microgravity environment. The experiment started by twisting the micrometer to its initial value (5mm) and then increasing the value 1mm per twist. The value was increased until ten parabolic flight cycles and the experiment was completed after the micrometer value had reached 14mm. The tensile properties were calibrated from the measurement with the micrometer (Fig. 7).

**Result and conclusion:**

Observation from tests under both conditions show crack propagation distances that differed when the initial value of the micrometer was applied. Under normal gravity, the crack propagation distances started at 0.3 mm and under microgravity at 7.2 mm. The explanation for this is, under normal gravity, the gravitational force limited the free movement caused by the straining rig but under microgravity condition, the gravity was small enough to be negligible; allowing free movement of crack propagation and resulting in crack propagation during the microgravity test being longer than the normal gravity test.

The pattern of crack growth under both conditions also differs whereby under the microgravity environment, we have planar crack growth but not under normal gravity. This is due to the effect of gravity. Under normal gravity, the gravitational force was less than the straining rig force, which explains why crack growth for a normal gravity test specimen is not in the planar position.

The minimum values under normal gravity experiments go from 0.3, peaking at 19.6 mm, while the minimum value for the microgravity experiment is 7.2, peaking at 25.7 mm. There was no maximum value for the microgravity experiment because the crack propagation exceeded the compact tension specimen.

**Outcome:** This study allowed a better understanding of Malaysian NR material and would facilitate the processing of materials to develop new types of low modulus NR. The experimental results and findings were presented and published in the Microgravity Science Workshop held on 1-2 September, 2008 at Putrajaya, Malaysia.

**ii. Theme: Characteristics of Superparamagnetic Iron Oxide Nanoparticles (SPION) in Microgravity**

**Team members (Malaysia):**

Multimedia University

Nur Asikin Zahari
Farah Adwina Mohd Alias
Adli Abu Yamin
Kho Dao Bin

Research Advisor / Dr. Ong Boon Hoong
and Prof. Mitsunori Matsumoto

**Objective:** To investigate the velocity changes of SPION due to microgravity by manipulating several variables, including:

i. Magnetic strength
ii. Size of magnetic particles
iii. Viscosity of the dispersion medium

**Procedure:** A custom made experimental kit was used to observe changes of SPION velocity under microgravity conditions. The SPION were dispersed in a closed testing tube, which was rotated before being subject to microgravity. Subsequently, a magnet was attached to the edge of the testing tube, toward which SPION were attracted and the velocity was observed and recorded.
The experimental kit consisted of 5 testing tubes. The effects of particles size, dispersion medium and magnetic strength on the SPION velocity were studied. We used 7nm, 10nm and 1um magnetic particles. The viscosity of the oil was 30 cP while that of the water was 10 cP.

**Result and conclusion:**
1) The SPION velocities under microgravity were slower compared to at the ground.
2) The SPION velocities under a stronger magnetic field were higher than with a weaker magnetic strength.
3) SPION that were larger had higher velocity than more compact SPION
4) SPION in a higher viscosity medium had lower velocity than SPION in less viscous media.

**Outcome:** The experimental results and findings were presented and published in the Microgravity Science Workshop held on 1-2 September, 2008 at Putrajaya, Malaysia.

**FY 2009**
Only one-half rack was available for Asian students for the year. Thai and Malaysian students coordinated and successfully managed to accommodate both sets of equipment into a single space.

**Theme: A study of water drops spreading in textiles under microgravity condition**

**Team members (Thailand):**
King Mongkut's University of Technology Thonburi /  
Wares Chancharoen  
Jakrapop Wongwiwat  
Wasin Tuchinda  
Pongsakorn Polchankajorn

**Research Advisor / Dr. Pajaera Patanathabutr**

**Objective:** Based on the assumption, “There should be a difference between the experiment under microgravity and normal gravity conditions in the static and dynamic physical model of the spreading water drops that can be tracked.” This assumption leads to the objective of this experiment, namely, to study the inter-molecular force in the water and fabric interactions under microgravity conditions.

**Procedure:** With a syringe, the electronic controller will turn the motor on to inject a few drops of water onto the fabric surface samples and track the information by using a high speed video camera and diode laser pointing directly to the water drops to create scattering lights and distinguish between the water surface and the dark background.

**Result and conclusion:** According to the measurement result of the spreading, it shows that the cotton spreading distances (Warp yarn) under microgravity exceeded those under normal gravity by 28.57%. Moreover, the cotton’s spreading distances were 16.67% more than those under normal gravity as
Fig. 10. Measurement of spreading distance of cotton

measured in (Weft yarn). These sample experiments were repeated 3 times, showing tiny variations but still revealing the above numbers.

The results were concluded as shown below.
1. The cotton spreading distances of warp yarn increase 28.57% more under microgravity as compared to normal gravity
2. The cotton spreading distances of weft yarn increase 16.67% more when microgravity is compared to normal gravity
3. The difference of spreading in each thread line under normal gravity is 14.28%
4. The difference of spreading in each thread line under microgravity is 11.11%

The other results were negative. The phenomena under microgravity and normal gravity were not apparently as expected.

However, for a contact angle experiment, the results gained from each gravitational condition were almost identical at the same wetting (in this case, the same spreading distance) and the variation was within the range of 5px, which is still within the error range of our image processing, namely negligible and could be disregarded.

1. “The difference between microgravity and normal gravity decreases ascendant to the fabric’s structure to the differences in fluid flow distance in each structure under the mentioned conditions.”
2. “The difference between microgravity and normal gravity increases the spreading distances of fluid flows for the mentioned specimens and conditions.”

**Outcome:** The students had the chance to present their reports on the special occasion of the 50th anniversary of their University.

**Theme: Magnetic Interaction of Magnetic Nanoparticles in Microgravity**

**Team members (Malaysia):**
Multimedia University
Low Piou Hou
Chan Sooi Loong
Research Advisor / Dr. Ong Boon Hoong and Dr. Lim Wee Keong
Objective: To investigate the dynamic characteristics of Superparamagnetic Iron Oxide Nanoparticles (SPION) under hyper- and microgravity.

Procedure: Approximately 5mg of SPION was sonicated in order to avoid agglomeration and injected into a tube filled with degassed water. The tube was sealed without any bubbles left inside. The suspended magnetic nanoparticles were then pumped at two different flow rates (namely 7.29 and 15ml/s), while its dynamic characteristics (flow patterns) were observed under the presence of two different magnets under both microgravity and hypergravity conditions.

Result and conclusion: Few significant changes of the SPION flow were observed during interaction with the magnetic field under hypergravity, microgravity and the transition period of microgravity to normal G condition.

Outcome: Draft manuscript in preparation.

FY 2010
Theme: Mortality Risk of Heart Failure Guinea Pigs during Parabolic Flight
Team members (Thailand):
Mahidol University
  Pattara Rattananwong
  Wasawat Vutthikravit
  Attawit Charoensri
Monash University
  Nichapat Rattanapuapun
Research Advisors: Prof. Jonggonnee Watanapermpool, Drs. Tepmanas Bupha-Intr, Tachapong Ngarmukos, Anusak Kijtawornra, Sawat Tantiphanwadi, Prof. Ichiro Miyoshi

Objective: To study the heart rate variability in doxorubicin-induced heart failure and controlled guinea pigs under normogravity, microgravity and hypergravity, and short term QT variability in doxorubicin-induced heart failure and controlled guinea pigs under normogravity, hypogravity and hypergravity.
Procedure: In each experiment, six adult healthy guinea pigs weighing 500 to 650 g were divided into two groups, control and heart failure. Systolic and diastolic heart failure were induced in the experimental guinea pigs by force feeding them with caffeine solution (15 mg/ml) 120 mg/kgBW/day for the first 5 days and continued 90 mg/kgBW/day until 15 days prior to the date of the parabolic flight. In addition, a single dose of doxorubicin (8 mg/kg) was intraperitoneally injected on day 12 of the caffeine-fed duration. The guinea pigs were kept in an air-controlled room and fed and watered throughout the study. For the same duration and study conditions, six control guinea pigs were injected with normal saline with a volume equivalent to that of the doxorubicin injection. All the processes were performed in the Center of Experimental Animal Science, Department of Comparative and Experimental Medicine, Nagoya City University. The study was approved by the IACUC committee of Japan AeroSpace and Exploration Agency, Mahidol University and Nagoya City University.

The guinea pigs were anesthetized with Xylazine: Zoletil (Tiletamine/ Zolazepam) 5:60 mg/kg body weight, intra-peritoneally. After deep anesthesia, the animals were placed onto a comfortable bed at ventral recumbency in a standing position. Electrode patches were attached to minimize impedance between the electrodes and skin without disturbing the guinea pigs so a bipolar transthoracic electrocardiogram between the points of rV2 and V2 could be obtained. The bipolar transthoracic ECG were obtained using a Biopac MP150 Data Acquisition Unit.

**Result and conclusion:** Supported by Prof. Ichiro Miyoshi, department of comparative and experimental medicine, Nagoya City University, 8 guinea pigs had heart failure induced. 2 were found to have perished between the induction periods. After the flight, all the induced guinea pigs’ hearts were stained with H&E in the department of physiology at the faculty of science in Mahidol university. Cardiac myocyte pictures were taken at the department of pathology at the faculty of medicine in Ramathibodi Hospital, Thailand.

Four of the six induced guinea pig cardiac myocyte specimens showed significant doxorubicin cardiotoxicity. Vacuolization and penetrating neutrophils, which were the hallmark of doxorubicin cardiotoxicity and cardiac myocyte inflammation, were seen. The remaining pair of the 6 induced guinea pigs showed no significant change.

All 6 guinea pigs subject to heart failure and 6 control guinea pigs were successfully recorded during the flight. ECG recording commenced 5 minutes before each parabolic condition. 2 control guinea pigs and 4 heart failure guinea pigs were recorded on 15 December, 2010 for 11 parabolic rounds. A further 4 control guinea pigs and 2 heart failure guinea pigs were recorded on 16 December for 12 parabolic rounds. Heart failure groups under microgravity condition showed a lower SDRR index compared to normogravity condition (p=0.008). Also, the heart failure groups under microgravity condition
demonstrated a lower SDRR index compared to hypergravity condition (p=0.029). There was no significant difference between the heart failure and control groups in the rMSSD index.

There was an increased risk of mortality for both groups, but no significant differences between the heart failure and control groups. Moreover, to ensure the accuracy of the result, the cardiacmyocyte was stained with mercury and an electron microscope used to grade the cardiotoxicity.

**Outcome:**

**Theme: Investigation of Patterned Ferrofluid in Microgravity and Hypergravity**

**Team members (Malaysia):**
Multimedia University/

Ho Kent Loong
Chong Teng Yee

Research Advisor / Dr. Ong Boon Hoong

**Objective:** To investigate the different patterns of ferrofluid due to surface tension by manipulating several variables, including:

i. Magnetic influence
ii. Variable of G state
iii. Types of liquid used in storage (oil- and water-based).

![Fig. 13. Experiment set up](image)
Fig. 14. Pattern of spikes on ferrofluid with respect to magnetic field and gravitational field

Fig. 15. The shape of the “shell” of the spikes with respect to the center point is drawn out for better observation. The data is tabulated as the above figure with additional overlay layers of all three G conditions.

Fig. 16. Side view of the ferrofluid shape
**Procedure:** Two types of ferrofluids (namely, water-based W40 and oil-based P50) were used in this experiment. A custom made sample holder was used to store these ferrofluids with different settings, such as fluid volume and position with respect to north or south magnetic poles. These ferrofluids were also exposed to the entire parabolic flight, during which few repeatable gravity transition cycles were experienced. The ferrofluid patterns were observed and recorded in order to study the gravitational effects.

**Result and conclusion:** A study of gravitational influence on the surface instability of ferrofluid was conducted under various G-conditions simulated by parabolic flight. The peak amplitude of ferrofluid was observed to increase with the drop in G-force, which tallied with the mathematical equation by Cowley and Rosensweig. Besides, an increase in the number of peaks of the perturbed surface also supports this theory. An interesting observation on the peak-trough distance suggests that not only peak, but also trough may be influenced by the magnetic field. In contrast with the setup in work done by Cowley and Rosensweig, a reverse-oriented observation was also conducted. The results show that the magnetic and gravitational fields switched roles in stabilizing and disturbing the fluid, compared to the case of normal orientation. The magnetic flux direction was found to influence the surface perturbation, which should be further studied with more detailed analysis.

**Outcome:** Conference presentation and journal publication. To date, one paper was accepted and presented at the IEEE International Magnetics Conference: 25-29 April, 2011, Taipei, Taiwan.

**Overall Outcome and Prospective**

**Thailand (2006-2010)**

Since NSTDA joined the APRSAF conference in 2006, Thailand has sent four microgravity experiments to join the JAXA student parabolic flight program involving the utilization of the space environment.

After each parabolic flight experiment was performed the students were well received and widely recognized in Thai public life, including the press and TV, and has generated countless interest among Thai students and educators each year. The success of this program has exceeded our expectations and the Thai government is in full support of this program. Our team at the NSTDA would like to take this opportunity to extend our sincere thanks to JAXA for providing this invaluable opportunity for Thai students and researchers.

**Malaysia (2007-2010)**

The parabolic flight program is an ideal platform for students to learn about teamwork, leadership time management and planning via hands-on and on side practical training. This program gave Malaysian students great experience of the ‘difficulties’, challenges and ‘pressure’ in performing experiments in ‘outer space’, starting from the development of experimental design, hardware fabrication and finally, to win the competition.

The programme was designed to promote Malaysian students with the opportunity to express their creative and innovative ideas in performing microgravity experiments. Participants were requested to submit research proposals on experiments under a microgravity environment which can be performed through a parabolic flight. The programme comprises writing up a mission proposal, including generating the design, documentation, presentation and finally obtaining the opportunity to conduct the microgravity experiment. The students might present the outcome of their research papers based on the experiment that has been performed and which may represent a valuable input for global scientific findings.
Students have the opportunities to explore and generate scientific collaboration between local and international scientists, thus updating their knowledge on the activities and key areas of microgravity sciences now and in future. The participation of Malaysia in this program will exert a significant impact on the establishment of microgravity experimental strategy to study fundamental issues, especially those related to nanomaterials and Malaysian polymers, by utilizing parabolic flight.

Through an experimental benchmark of Malaysia compared to other countries based on its 3-time participation in this program (2007-2010), there is expected to be the potential to enhance the quality of the experiment. Participating students in this program are selected by lecturers as outstanding individuals having shown high potential for connecting at a master level. Students are expected to utilize research in this area and contribute to developing the country's human capital via additional Researchers, Scientists & Engineers (RSE) in the field of interest, particularly space science and microgravity sciences. To date, at least 2 participated students had preceded their Master’s degree.

The National Space Agency of Malaysia (ANGKASA), as organizer and coordinator of this program at the national level, can benefit either directly or indirectly from the programme. The ANGKASA officers involved gained technical experience in the management and conducting of the microgravity research program from the beginning of experimental selection, including production and circulation of the RFP, manufacture of experimental materials and the safety and regulations of performing experiments in aircraft. Besides, they can also receive updates on activities and key areas of microgravity sciences.

The ANGKASA officers are also exposed to communication and interaction with external parties, which will strengthen international ties. Through this program, the role of ANGKASA has been clearly shown, to determine its responsibilities in providing exposure and awareness of general space science and microgravity sciences. By this program, ANGKASA can also identify any potential research and development projects to be developed, especially to prepare the nation for the next Angkasawan™ (Malaysian Astronaut) program.

For 2011, the program will also consist of promotion and outreach activities. A series of lectures will be held by inviting external experts to clearly explain microgravity science, its benefits and methods, and experiments that can be performed during parabolic flight, including the KIBO utilities. With the cooperation of KUOA, two JAXA experts will be giving talks for the 5 days of outreach activities, which cover 5 zones throughout Malaysia. The young researchers, scientists, lecturers and university students are to be identified as targeted groups.

The parabolic flight program will expand the potential for usage of the space environment via the synergy of international collaboration between Malaysia and Japan. This program was a valuable opportunity for Malaysia, not only to enter aerospace studies but also to educate youngsters and also convince the public that similar space experiments can also be performed on Earth, subject to certain advantages and disadvantages. ANGKASA believes this will spur many young Malaysian talents to get involved under microgravity research and lead Malaysia to be an active participant in the international arena in future!
Outlook

The unique experience with parabolic flight is extremely effective in stimulating students’ intentions toward building their careers in science and technology. Students encounter various tasks of different nature, such as project management, import-export controls, transportation and aviation safety and in addition to solving scientific and technological difficulties, are expected to contribute to their countries in human capital development as additional Researchers, Scientists & Engineers (RSE) in the microgravity sciences field. These relevant practical experiences are expected to be extremely salutar for their career development.

Moreover, exchanges among student teams were invaluable, especially for Japanese students. This program will become even more beneficial if the following are translated into action. Increased opportunities are key for all. To date, only one or two Asians and six or seven Japanese student teams can participate in flight experiments each year. Moreover, the students’ subjects have been solely accompanied to the flight experiments by professional researchers to date. As the secondary payload, students’ experiments have not narrowed to prevent any interference with the main research purposes, meaning flights dedicated to student’s experiments are strongly desirable. The increased opportunity for flights makes it easier for students from Asian countries other than Malaysia and Thailand to participate in the program. Dedicated flights will not only increase the experimental opportunities but also greatly enhance exchange among students, which is key to developing future space professionals.

References

2) Asia-Pacific Regional Space Agency Forum: http://www.aprsaf.org
